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Momita Konwar
Department of Textiles and Apparel Designing, Faculty of Community Science, Assam Agricultural University, Jorhat, Assam, India

Rickey Rani Boruah
Department of Textiles and Apparel Designing, Faculty of Community Science, Assam Agricultural University, Jorhat, Assam, India

Syeda Sahnaz Yasmin
Department of Textiles and Apparel Designing, Faculty of Community Science, Assam Agricultural University, Jorhat, Assam, India

Priyanka Borah
Department of Textiles and Apparel Designing, Faculty of Community Science, Assam Agricultural University, Jorhat, Assam, India

Corresponding Author:
Rickey Rani Boruah
Department of Textiles and Apparel Designing, Faculty of Community Science, Assam Agricultural University, Jorhat, Assam, India

Study on properties of Eri-union fabrics developed with cotton and polyester yarn

Momita Konwar, Rickey Rani Boruah, Syeda Sahnaz Yasmin and Priyanka Borah

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Abstract
The union fabrics were made from eri with cotton yarns and eri with polyester yarns using satin weave. The semi-automatic power loom was used to construct the union fabric. The 2/60s eri silk yarn was used as warp and 2/40s was used for cotton and polyester yarns. The pure eri/ eri fabric was also constructed to compare the different performance properties of eri /cotton and eri / polyester union fabrics. Yarn count, fabric count, fabric weight, tensile strength, elongation, crease recovery, stiffness, thickness, fabric cover and drapability were observed and analyzed for the developed union fabrics which met the properties required for the construction of apparel. An evaluation performa was prepared to evaluate the aesthetic and handle properties of the developed fabrics. It was found that satin weave union fabrics were found better than the pure Eri fabric.

Keywords: Union fabric, Eri, cotton, polyester

Introduction

Union fabric is made by using different yarn in warp and weft direction. Various kinds of union fabrics can be produced by combination of cotton, rayon, ramie, polyester, acrylic etc. with silk to reduce the cost of the silk fabric as well as the weight of the fabric (Nayak *et al*., 2009) [11].

Eri silkworm belongs to two species, *Samia cynthia ricini*, *Philosamia recini*. The name eri is derived from the Assamese word ‘era’ which means castor as the silkworms feed on castor plants Eri silk is known as Ahimsa Silk or Peace Silk. Eri silk found in northeast India and some parts of China, Japan, said by *Wangkia, 2017*. Eri silk is also known as endi or errandi in India. The woolly white silk is often referred to as the fabric of peace when it is processed without killing the silkworm. This process results in a silk called Ahimsa silk. Moths leave the cocoon and then the cocoons are harvested to be spun. The eri silkworm is the only completely domesticated silkworm other than *Bombyx mori*. Eri silk is a staple fiber and it has good fineness, density, cross-sectional shape and surface properties. It is darker and heavier than other silks. It feels like cotton, has luster like other silks, bulkiness and warmth like wool and is the softest among all silk fibers. All these properties make it more unique than other fibers.

Eri Silk also has excellent thermal properties. Development of new products and diversification in the use of available material of Eri Silk offers a lot of opportunities for innovations. According to Nadiger, *et al*., 2007 [8], manipulating at various stages viz., yarn, fabric and garment development can bring about diversification in the Eri products. Eri silk is the softest and warmest amongst all the silks and has immense potential for commercial exploitation by making finest quality Blankets, Sweaters and Suiting materials. Polyester fibers have high strength and are resistant to shrinking and stretching. Fabrics are quick drying and tend to have wrinkle resistance and crease retention, wet and dry. Polyester is used alone and in blends. It has been one of the first fibers to be developed in fabrics with durable press features. Cotton has moderate to average strength compared to other fibres. It tends to get stronger when wet which means it is easy to care for. Since the resiliency and elastic recovery of cotton are low, and elongation is comparatively low also, fabrics wrinkle easily and do not recover from creasing. Cotton fibers are very strong as compared to other natural fibres. The strength increases by 25 percent on wetting than when it is dry.

This property has its significance for less care is required during washing of the fabric. Cotton fibres mostly have 8.5 percent of the moisture but have ability to absorb 15-20 percent of the moisture. Due to this property it takes time while drying. This is a positive property for cotton fabrics because they can absorb perspiration easily and gives the feeling or coolness. That is why cotton is good for summers, A union fabric is a textile fabric, which is woven from different yarns in warp and weft. In this type of fabrics the properties of two different yarns are combined together to get a new fabric having the properties of both the yarns. Union fabric enables the weavers to combine two different sets of yarns so that good qualities are emphasized and poor qualities are minimized, thereby having the fabrics with better functional properties. Union fabrics, if woven with eri in one direction and cotton and polyester in the other direction using satin weave and the resultant fabrics are expected to have better functional properties.

Materials and Methods

1. Selection and collection of yarn: Spun eri silk yarn was selected for the present study and was collected from Fabric Plus Pvt. Ltd., Guwahati, Assam. Cotton and polyester yarns were selected to construct union fabrics and collected from local market of Jorhat district of Assam.

2. Properties of selected yarn: A preliminary yarn test was conducted before weaving to observe the parameters such as yarn count (Ne), twist (tpi), tenacity (g/den), elongation (%) and twist direction.

Table 1: Properties of yarn

Properties	Types of yarn		
	Eri silk	Polyester	Cotton
Yarn count (Ne)	2/60^s	2/40^s	2/40^s
Twist (tpi)	12	9	14
Tenacity (g/den)	2.6	3.4	2.4
Elongation (%)	20	22	18
Twist Direction	Z	Z	Z

3. Construction details of Eri and Eri union fabrics: The fabrics were woven on semi-automatic power loom using satin weave. Three different types of union fabrics namely Eri × Eri, Eri × Cotton and Eri × Polyester were produced in Fabric Plus Pvt. Ltd., Guwahati, Assam wherein Eri yarns were used as warp and Cotton and Polyester yarns were used as weft. Developed fabrics were assessed for geometrical properties, performance properties and subjective assessment. Statistical results of construction details of Eri and Eri union fabrics revealed in Table 2.

Table 2: Constructional details of Eri and Eri union fabrics

Fabrics	Weave types	Direction	Yarn	Yarn type	Yarn count	Reed count
Eri/Eri (EES)	Satin	Warp	Eri	2 ply	2/60s	52s
		Weft	Eri	2 ply	2/60s	
Eri/Cotton (ECS)	Satin	Warp	Eri	2 ply	2/60s	52s
		Weft	Cotton	2 ply	2/40s	
Eri/Polyester (EPS)	Satin	Warp	Eri	2 ply	2/60s	52s
		Weft	Polyester	2 ply	2/40s	

Table 2 reveals that 2 ply Eri, Cotton and Polyester yarns were used to construct fabrics. 52s Reed count was used for weaving satin weave with yarn count 2/60s for Eri and 2/40s for Cotton and Polyester yarn.

Results and Discussion

Determination of Geometrical properties of constructed fabrics: Geometrical properties of constructed fabrics such as Fabric counts, fabric weight and fabric thickness were determined.

Fabric count in woven textile material is the number of warp and weft yarns per square inch area while the fabric is free from wrinkles. The number of warp and weft yarns in one square inch of the fabric is counted by using Paramount pick glass using ASTM-D123 test methods at five random selected places across the width and along the length of the test specimens. The region near the selvedge should be avoided because the spacing of thread is often a little different than in the body of the cloth

Fabric thickness is the distance between the upper and lower surface of the material measured under a specified pressure, expressed in mm. fabric thickness was determine by Shirley's Thickness Tester using ASTM-D 1777 test methods. The specimen chosen were free from folds, crushing or distortion, wrinkles. Five readings were recorded and mean was calculated.

Fabric weight is expressed as mass per unit area in g/sq.mt. A sample of 5 × 5 cm was cut and weighed on an electronic weighing balance using ASTM-D3776 test method to determine the weight per sq.mt (g). Further, warp and weft threads were separated and weighed to calculate respective percentages.

Table 3: Evaluation of Geometrical properties of constructed Eri union fabrics

Sl. No	Fabrics	Fabric count		Fabric Thickness (mm)	Fabric weight (g/m^2)
		Warp	Weft		
1.	Eri/Eri (EES)	75	72	0.52	170
2.	Eri/Cotton (ECS)	74	78	0.49	167
3.	Eri/Polyester (EPS)	78	81	0.43	156

Table no. 3 revealed that Fabric count in Eri/Polyester (EPS) is more in both warp and weft direction i.e. 78 and 81 respectively followed by Eri/Cotton (ECS) i.e. 74 and 78 in warp and weft direction respectively which is due to variation in the fibre content, type of yarn, yarn coarseness and fineness, weaving technique, compactness of the weave and type of loom on which the fabric was woven. The eri/ polyester satin (EPS) weave union fabric was found to be thinner i.e. 0.43mm followed by eri/ cotton satin (ECS) union fabric i.e 0.49mm while in the control fabric (EES), thickness was found 0.52mm. The weight of the eri union fabrics significantly decreased as compared to pure eri (EES) fabric i.e. 170 g/m^2. The lowest weight i.e. 156g/m^2 was found in eri/ polyester union fabric. It may be due to the lowest thickness of polyester yarn and fabric.

Determination of performance properties of Eri union fabrics:

The wicking height, cloth dimensional stability, moisture regain, drape coefficient, fabric stiffness and crease recovery of the eri and its union fabrics were evaluated. Wicking height was calculated using method suggested by Miller *et al.* 1984 [10], wicking is the capacity of a fabric to transport absorbed sweat away from the point of absorption, usually the skin and the rate which it does so. A length of

test specimen, pre-conditioned in 25+ 2°C at 65+2 percent relative humidity was suspended in a reservoir of distilled water. The height reached (at a constant time of 2 minutes) by the water in the fibers above the water level in the reservoir of distilled water was measured and recorded.
Cloth dimensional stability was measured in terms of shrinkage percentage. Fabric sample of 25cm x 25cm was taken and initial length of 20cm was marked both in warp and weft direction. Test samples were soaked in the soap solution of 2gpl at room temperature for 1 hour. The sample was rinsed thoroughly in cold water and dried under shade and then pressed gently without stretching. Further final lengths were measured and shrinkage percentage was calculated. Moisture regain is expressed as the weight/weight percentage (w/w%) of water in a material versus the material's dry weight. The weight of the water is obtained by after the dried material has been equilibrated at 65% relative humidity at 22C.
Fabric drape is the extent to which a fabric deforms when it allowed to hang under its own height. Drape coefficient is the area covered by the shadow of the draped specimen expressed as percentage of the area of annular ring of the fabric. For determining drapability of the fabric the Eureka Drape Meter was used. The specimen of 30cm in diameter were cut by means of circular template and kept on supporting disc of the drape meter. Switching on the lamp, it gives the shadow of the draped area, which was taken on a paper and was weighed. Similarly, drape shadow area of the template and supporting disc was also taken. Thus, drape coefficient was calculated by using the formula (Booth, 1968) [2].

$$F = \frac{As - Ad}{AD - Ad} \times 100$$

Where
As =Weight of the actual projected area of the specimen
AD= Weight of the specimen
Ad= Weight of the supporting disc.
F=Drape co-efficient.

Fabric stiffness is the resistance of the fabric to bending. Bending length is the length of the fabric that bends under its own weight to a definite extent. The test samples were tested as directed in BS test method: 3356- 1961. Test specimen was cut with help of template and then both template and test specimen was placed on the platform with the fabric underneath. Both were slowly pushed forward. The strip of fabric was started to a droop over the edge of the platform and the movement of the templates and the fabric was continued until the tip of the specimen viewed in the mirror cuts both index lines. The bending length was read off from the scale mark opposite a zero line engraved on the side of the platform. Five readings were recorded by using Shirley's stiffness tester.
Crease recovery is nothing but allowance of the fabric to recover from the crease. The test samples were tested as directed in IS method: 4681-1968 by using Shirley's crease recovery tester. Samples were cut both warp and weft way from the fabric with a template, 2 inch long by 1 inch wide. It was creased by folding into half and placed under a weight of 2 kg for 5 minutes. The weight was removed and the specimen was transferred to the fabric clamp on the instrument using forceps and was allowed to recover from the crease for 5 minutes. As it recovered the dial of the instrument was rotated to keep the free edges of the specimen in line with the knife edge. At the end of the time period as it was allowed for recovery, usually 1 minute the recovery angle in degrees was read on the engraved scale. Readings were recorded for both warp and weft separately.

Table 4: Performance properties of Eri union fabrics

Weave type	Fabrics	Wicking height(cm)		Cloth dimensional stability (%)		Moisture Regain (%)	Drape coefficient (%)	Fabric stiffness (cm)		Crease Recovery (degree)	
		Warp	Weft	Warp	Weft			Warp	Weft	Warp	Weft
Satin	Eri/Eri (EES)	3.70	3.70	17.88 (69.40)	17.94 (69.70)	9.64	41.62	3.13	2.78	89.75	94.25
	Eri/Cotton (ECS)	4.8	4.8	19.28 (76.40)	19.76 (78.80)	9.89	47.23	2.70	2.38	110.75	123.25
	Eri/Polyester (EPS)	2.8	2.8	17.60 (68.00)	17.28 (66.40)	8.72	57.4	1.70	1.55	127.75	125.25

The mean wicking height, cloth dimensional stability, moisture regain, drape coefficient, fabric stiffness and crease recovery of the Eri and Eri union fabrics were given in table 4. It depicts that mean wicking height is improved in both warp and weft direction of Eri/Cotton (ECS) union fabric compared to Eri/Polyester (EPS) union fabric or pure eri fabric. Highest was found in weft direction of Eri/Cotton (ECS) union fabric i.e. 4.8 cm and lowest was found in weft direction of Eri/Polyester (EPS) union fabric i.e 2.8 cm. Wicking height is depends on nature of fabric and the type of yarn used. In cotton fabric absorbency is more than the other fabric so fiber absorbs more amount of water.
Eri/Cotton (ECS) union fabric exhibited the highest dimensional stability compared to the Eri/Eri (EES) and Eri/Polyester (EPS) in weft(78.80 %) direction as cotton being cellulosic in nature has a tendency to shrink readily thus making the fabric more absorbent. Whereas, Eri/Polyester (EPS) union fabric possessed higher dimensional stability in warp way (68.00%) as crystalline region of Eri makes the fabric less absorbent and higher crystalinity delays the water molecule to enter into the polymer system.
It can be observed from the table that Eri/Cotton (ECS) union fabric showed highest percentage of moisture regain i.e. 9.89% compared to Eri/Eri (EES) and Eri/Polyester (EPS) union fabrics i.e 9.64% and8.72% respectively.
The Eri/Polyester (EPS) union fabrics shows highest drape coeficient i.e. 57.4 % followed by Eri/Cotton (ECS) union fabric i.e. 47.23 % as compared to Eri/Eri (EES) fabrics i.e 41.62 %. It may be due to high stiffness of eri yarn.
The fabric stiffness of both the warp and weft direction of Eri/Polyester (EPS) union fabric was found 1.70 cm and 1.55 cm respectively. On the contrary, the fabric stiffness of both the warp and weft direction of Eri/Cotton (ECS) fabric was found more i.e. 2.70 cm and 2.38 cm, it may be due to the sizing applied to cotton yarns prior to weaving.

The crease recovery of eri/ polyester union fabric resulted in better recovery i.e 127.75º and 125.25º in warp and weft direction respectively, followed by eri/cotton union fabric i.e 110.75º and 123.25º in warp and weft direction respectively. Pure eri fabric found less crease recovery i.e. 89.75º and 94.25º in warp and weft direction respectively. This may be attributed to the high resiliency of polyester fiber and the type of weave.

Subjective assessment of constructed union fabrics:
The aesthetic and handle properties of the developed eri union fabrics were analyzed by assessing 50 respondents from different age groups, sex, education level and occupational groups. Properties such as appearance, texture, luster, handle and suitability for the construction of apparel were analyzed by the respondents using evaluation performa. Parameters were given in Table 3.

Table 5: Respondents' opinion on the constructed fabric

Parameter	Grade	Eri/Eri (EES)	Eri/Eri (EES)	Eri/Eri (EES)
General appearance	Good	95	95	100
	Fair	5	5	0
	Poor	0	0	0
Texture	Fine	0	12.5	0
	Medium	100	87.5	100
	Rough	0	0	0
Luster	High	0	50	100
	Moderate	100	50	0
	Low	0	0	0
Handle(feel)	Softness	97.5	95	100
	Stiffness	2.5	0	0
	Roughness	0	0	0

Conclusion
Union fabric is a textile fabric in which two different yarns are used in both warp and weft. The main motive of this study was to combine two different yarns i.e. cotton and polyester with eri so as emphasized good qualities and minimized poor qualities of the selected union fabrics. The fabrics were made on a semi automatic loom and the Geometrical properties, performance properties and subjective assessment of the fabrics were analyzed. It was observed that eri /cotton and eri/polyester union fabrics had better performance properties with increasing crease resistance and drapability of fabric keeping at par eri/eri fabrics. Hence it is concluded that eri/cotton and eri/polyester union fabric have better durability, lighter in weight and good draping quality. Besides this, fabrics have unique appearance and provide extra luster.

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